EFFECT OF ARBUSCULAR MYCORRHIZA FUNGI INOCULATION ON TEAK (*Tectona grandis* Linn. F) AT CIKAMPEK, WEST JAVA

Ragil S.B. Irianto and Erdy Santoso[1]

ABSTRACT

The aim of this study was to identify the effect of Arbuscular Mycorhiza Fungi (AMF) on the early growth of teak (*Tectona grandis* Linn. F) plantation. Teak seedlings were inoculated with *Glomus aggregatum* or Mycofer (mixing of four Arbuscular Mycorrhiza Fungi (AMF) : *G. margarita, G. manihotis, G. etunicatum* and *Acalospora spinosa*) at the time of transplantation. At three months old the seedlings were planted in Cikampek experimental forest. Results showed that application of *G. aggregatum* or mycofer to teak could accelerate height and diameter growth by up to 61% and 47%, respectively, after three months in the field.

Keywords: teak, *Tectona grandis*, AMF, *Glomus*, *Acalospora*, seedling

I. INTRODUCTION

Teak belongs to Verbenaceae which symbioses with Abuscular Mycorhiza Fungi (AMF). In Indonesia, more than 1 million hectares of lands planted with teak especially in Java Island and Lampung Province. Perum Perhutani[2] alone has a total of teak plantation of 1,423,676 hectares mostly in East and Central Java producing teak logs of about 800,000 m^3/year. Due to the high economic value of teak, currently many farmers in Java, Sumatra and Kalimantan are in high wood of planting teak with seedlings from seed or tissue culture production. Perum Perhutani and farmers need millions seedlings to replace teak plantation harvested every year. Teak is commonly planted on land with low soil fertility, therefore it need fertilizer and beneficial symbiont such as AMF.

Application of AMF (*Glamus agregatum* and *Mycofer* R.) on *T. Grandis* seedlings could accelerate the growth of height and diameter (Asmanah, 2000). The symbiotic of AMF with higher plants plays an important role in plant nutrition cycle (Harley and Smith, 1983). The AMF stimulates the growth of many tropical trees and shrubs by enhancing the uptake of nutrient elements such as phosphorus, nitrogen, potassium and by increasing the resistance of plants to drought stress and root pathogens (Janos, 1988; Michelsen and Rosendahl, 1990). The aim of this study was to determine the effect of AMF inoculation on the growth of young teak plantation in the field.

---

[1] Forest and Nature Conservation Research and Development Center, Bogor

[2] Perum Perhutani is a state-owned company holding a mandate for managing production in Java, which is mainly teak plantation

II. METHOD

A. Location

This research was conducted in Cikampek Experimental Forest Purwakarta District - West Java. This site has an annual rainfall of 1891 mm. The soil type is an association of red latosol and reddish brown latosol.

B. Treatment

Three seedlots of *T. grandis* namely seedlot 52, 58 and 63 were obtained from The Centre for Forest Resources Development, Perum Perhutani, Cepu Central Java. Soil media were yellowish red podzolic from dipterocarp plantation. Two kinds of AMF : *Glomus aggregatum* (produced by Osaka Gas) and Mycofer (consisting of 4 species AMF i.e. *G. margarita, G. manihotis, G. etunicatum* and *A. spinosa*) were inoculated individually. The innoculated teak seedlings were planted in Cikampek Experimental Forest in West Java using 3 x 4 m and 30 x 30 x 30 cm planting holes on December 1999.

C. Data Analysis

Parameters observed from plant growth study in the field consisted of height and diameter of three-month-old of *T. grandis* (3 months after planting). Data were analysed with Duncan's multiple range test using SAS 6.12 software.

III. RESULTS AND DISCUSSION

Results of height and diameter of *T. grandis* inoculated with AMF in 3 seedlots are listed in Table 1.

Table 1. Effect of Arbuscular Mycorrhiza Fungi on *T. grandis* (Seedlot 52, 63 and 58) growth in the field.

Seedlot	Parameter	Mycorrhiza		
		G.aggregatum	Mycofer	Control
52	Height (cm)	48.06 a (61.38)	40.73 b (36.77)	29.78 c (0.00)
	Diameter (mm)	10.99 a (14.96)	8.99 b (5.96)	9.56 b (0.00)
63	Height (cm)	38.50 a (60.62)	35.51 a (48.14)	23.97 b (0.00)
	Diameter (mm)	8.39 a (20.89)	8.09 a (16.57)	6.94 a (0.00)
58	Height (cm)	31.48 ab (16.51)	38.34 a (41.89)	27.02 a (0.00)
	Diameter (mm)	8.95 b (16.54)	11.28 a (46.88)	7.68 b (0.00)

Notes:
1. Means followed by the same letters are not significantly different at p=0.05 according to Duncan's multiple range test.
2. Numeric in the parantheses denote percentage increase over control

Application of *G. aggregatum* resulted in a higher effect on seedlot 52 and 63 with the acceleration of height was 16%. Meanwhile, plants infected by mycofer on seedlot 58 showed a higher growth than those on seedlot 52 and 63. According to Triwahyuni (2000) inoculation of mycofer provides a higher result than that of *G. aggregatum* in terms of height of seedlings. On the other hand, Chavez and Ferrera-Cerato (1990) reported that AMF effects differ widely with host-endophyte combinations in micro propagated strawberry. This might be due to the existence of some physiological host preference/specificity in these fungi. According to Suhendi (2005, pers. comm.), the difference of growth on three seedlots could also be caused by genetic variation.

In general as shown in Table 1, mycorrhiza has a great influence in increasing the height and diameter (plant growth) compared to non-mycorrhizal plant. The majority of soils in tropical ecosystem are known to be deficient of available P and N, both of which are important nutrients for growth (Kang and Wilson, 1987). Harley and Smith (1983) reported that AMF has a significant effect in improving plant growth when little phosphate is present in the soil. Roo-external AMF mycelium grows well and increases the soil volume which is exploited for P uptake. Higher concentration of potassium (K) and nitrogen (N) are found in mycorrhizal than non-mycorrhizal plants (Sieverding, 1991; Irianto and Utami, 2001). Micronutrients such as Zinc (Zn), copper (Cu), sulphur (S), boron (B), molybdenum (Mo), iron (Fe), manganese (Mn) and chlorine (Cl) are generally found in higher concentration in mycorrhizal than non-mycorrhizal plants (Sieverding, 1991). Furthermore, Druge and Schonbek (1992) reported that AMF symbiosis could raise internal cytokinin levels and this is as a main factor causing improvement of plant growth.

Table 2. Effect of Arbuscular Mycorrhiza Fungi on *T. grandis* (seedlot 63) growth in the field

Kinds of Mycorrhizas	Height (cm)	Diameter (mm)
G. aggregatum	38.50 a (60.62)	8.39 a (20.89)
Mycofer	35.51 a (48.14)	8.09 a (16.57)
Control	23.97 b (0.00)	6.94 a (0.00)

Notes:
1. Means followed by the same letters are not significantly different at p=0.05 according to Duncan's multiple range test.
2. Numeric in the parantheses denote percentage increase over control

Table 3. Effect of Arbuscular Mycorrhiza Fungi on *T. grandis* (seedlot 58) growth in the field

Kinds of Mycorrhizas	Height (cm)	Diameter (mm)
G. aggregatum	31.48 ab (16.51)	8.95 b (16.54)
Mycofer	38.34 a (41.89)	11.28 a (46.88)
Control	27.02 a (0.00)	768 b (0.00)

Notes:
1. Means followed by the same letters are not significantly different at p=0.05 according to Duncan's multiple range test.
2. Numeric in the parantheses denote percentage increase over control

Inoculation of G. *aggregatum* to seedlot 52 could accelerate the height and diameter of young plant by 61.38% and 14.96% and seedlot 63 by 60.62% and 20.89%, respectively, compared to control. While inoculation of mycofer to seedlot 52 could accelerate the growth of height and diameter by 36.77% and 5.96% and seedlot 63 by 48.14% and 16.57%, respectively, compared to control (Table 1 and 2). Moreover, inoculation of mycofer to seedlot 58 could accelerate greater than G. *agregatum* to the height and diameter of three-month-old young plant in the field (Table 3).

Plants infected by G. *aggregatum* showed higher result on seedlot 52 and 63 with the acceleration of height more than 60%, but for seedlot 58 the acceleration of height was 16%. Meanwhile, plants infected by mycofer showed higher result on seedlot 58 than seedlot 52 and 63. These results were similar to the results reported by Triwahyuni (2000); inoculation of mycofer to seedlot 3 and 7 provided the higher result than G. *aggregatum* to height of seedlings. Chavez and Ferrera-Cerrato (1990) reported that AMF effects differ widely with host-endophyte combinations in micro propagated strawberry. This might be due to the existence of some physiological host preference/specificity in these fungi.

Mycorrhizal plants have a great influence in increasing the height and diameter (plant growth) compared to non-mycorrhizal plant (Tables 1, 2 and 3). The majority of soils in tropical ecosystem are known to be deficient in available P and N, both of which are important nutrients for growth (Kang and Wilson, 1987). Harley and Smith (1983) reported that AMF has their significant effect in improving plant growth when little phosphate is present in the soil. Root-external AMF mycelium grows well and increases the soil volume where is exploited for P uptake. Higher concentration of potassium (K) and nitrogen (N) are found in mycorrhizal than non-mycorrhizal plants (Sieverding, 1991; Irianto and Utami, 2001). Micronutrients such as Zinc (Zn), copper (Cu), sulphur (S), boron (B), molybdenum (Mo), iron (Fe), manganese (Mn) and chlorine (Cl) are generally found in higher concentration in mycorrhizal than non-mycorrhizal plants (Sieverding, 1991).

Furthermore, Drüge and Schönbeck (1992) reported that AMF symbiosis could raise internal cytokinin levels and this is as main factor causing improvement of plant growth.

IV. CONCLUSION

Seedlings inoculated with G. *aggregatum* or mycofer could accelerate height and diameter growth of young plant by up to 61% and 47%, respectively, after three months in the field. Application of AMF at nursery may be used to increase growth of seedlings in the nursery and plants in the field, hence reducing the use of synthetic fertilization.

ACKNOWLEDGEMENT

This research was funded by Osaka Gas Co. Ltd. Japan. We thank to Mr. Sugeng Santosa and Mr. Najmullah for their help in the field.

REFERENCES

Asmanah, N. 2000. Effect of Arbuscular Mycorrhiza Fungi on *Tectona grandis* L.f. in Nursery. Bachelor Thesis, Department of Biology Universitas Pakuan, Bogor.

Chavez, M.G. and R. Ferrera-Cerato. 1990. Effect of vesicular-arbuscular mycorrhiza on tissue culture-derived plants of strawberry. Hort. Sci. 25:903-905.

Drüge, U and F. Schönbeck. 1992. Effect of vesicular-arbuscular mycorrhizal infection on transpiration, photosynthesis and growth of flax (*Linum usitatissiumum* L.) in relation to cytokinin levels. J. Plant Physiol. 141 : 40-48.

Harley, J.L. and S.E. Smith. 1983. Mycorrhizal Symbiosis. Academic Press, New York.

Irianto, R.S.B and S. Utami. 2001. Effect of arbuscular mycorrhiza fungi on *Paraserianthes falcataria* seedlings. A Research Report, Unpublished.

Janos, D.P. 1988. Mycorrhiza applications in tropical forestry: are temperate-zone approaches appropriate? *In* Ng F.S.P. (Editor), Trees and Mycorrhiza. Forest Research Institute, Kuala Lumpur, Malaysia, pp. 133-188.

Kang, B.T. and G.F. Wilson. 1987. The development of alley cropping as a promising agro forestry technology. *In* Steppler H.A. and P.K.R. Nair (Eds.) Agro forestry: A Decade of Development, pp 227-243. ICRAF, Nairobi, Kenya.

Michelsen, A. and S. Rosendahl. 1990. The effect of VA Mycorrhizal fungi, phosphorus and drought stress on the growth of *Acacia nilotica* and *Leucaena leucocephala* seedlings. Plan Soil 124: 7-13.

Schmidt, F.H. and J.H. Ferguson. 1951. Rainfall type based on wet and dry period ratios for Indonesia with Western New Guinea. Jawatan Meteorologi dan Geofisika, Verh No. 42, Jakarta.

Sieverding, E. 1991. Vesicular-Arbuscular Mycorrhiza Management in Tropical Agro system. GTZ GmbH.

Triwahyuni, C. 2000. Effectiveness of some arbuscular mycorrhiza fungi on teak (*Tectona grandis* Linn F). *In* Using Mycorrhiza as Friendly Biotechnological Agent in Increasing Land Productivity on Forestry, Agriculture and Estate in New Millennia Era. National Conference Mycorrhiza I, Bogor 15-16 November 1999.